Oct. 30, 1934. M. A. LISSMAN 1,978,802

CENTRIFUGAL CLASSIFYING APPARATUS

Filed March 22, 1932 5 Sheets-Sheet 1

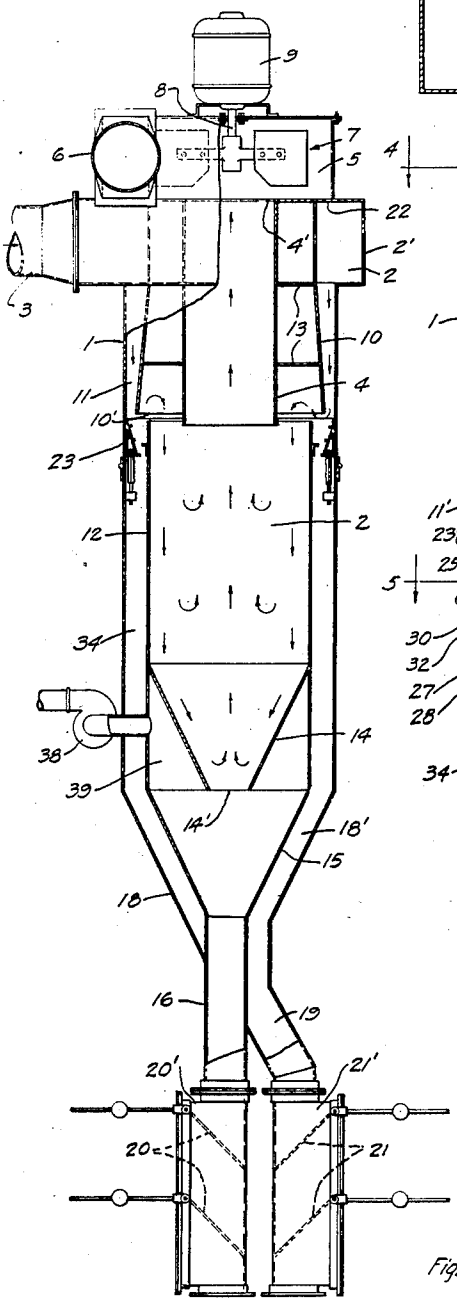

Fig. 1

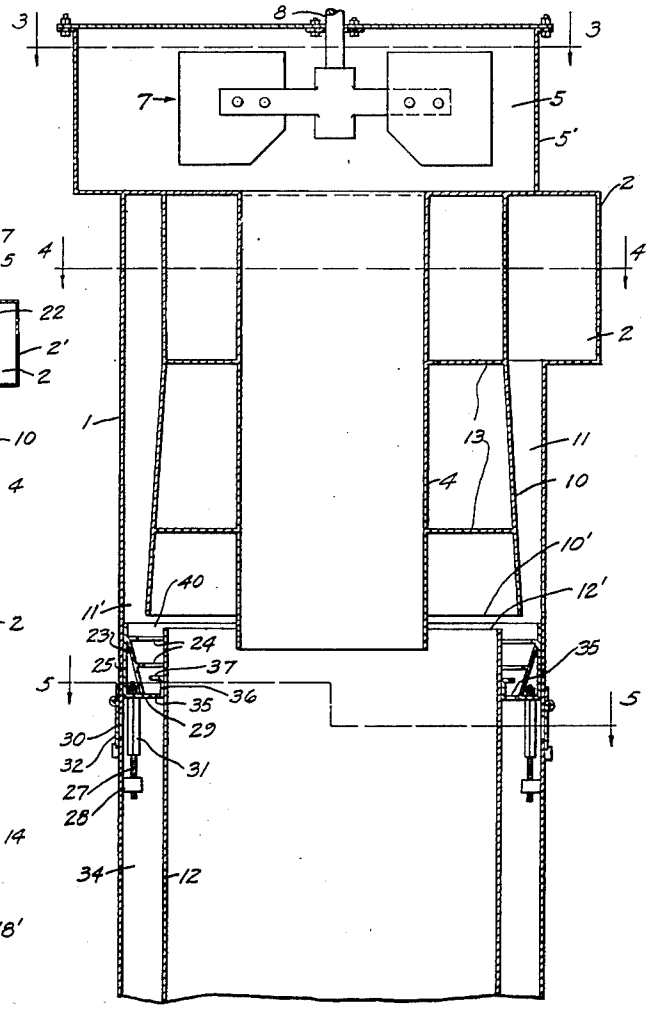

Fig. 2

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Filed March 22, 1932 5 Sheets-Sheet 2

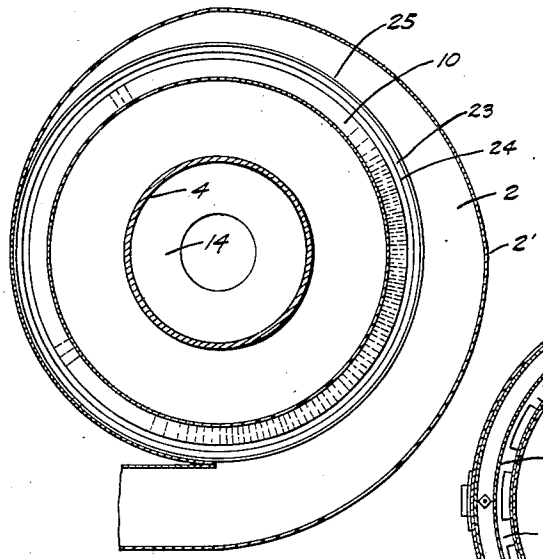

Fig. 4

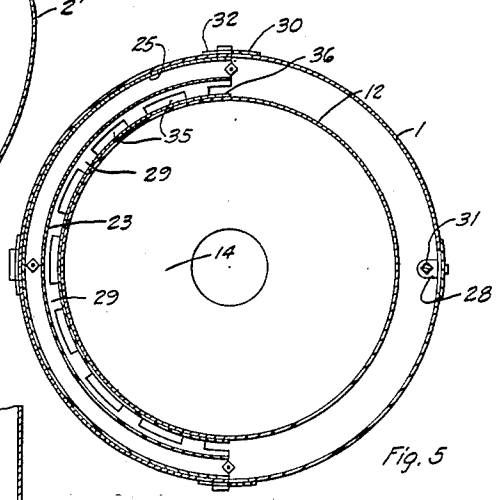

Fig. 5

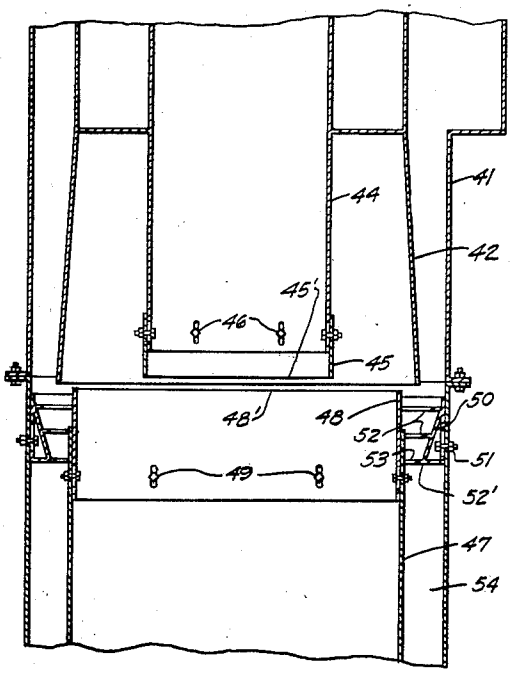

Fig. 6

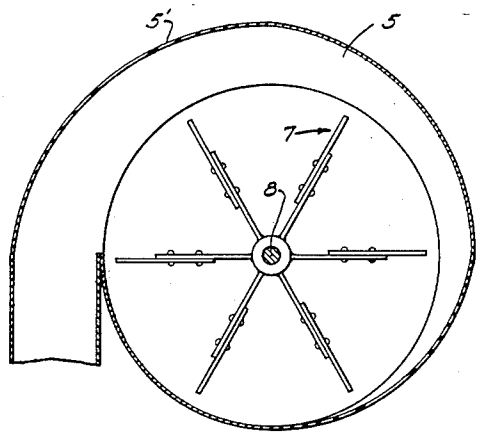

Fig. 3

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Filed March 22, 1932 5 Sheets-Sheet 3

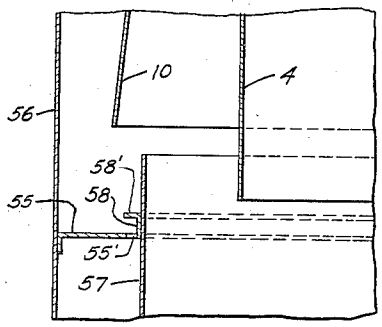

Fig. 7

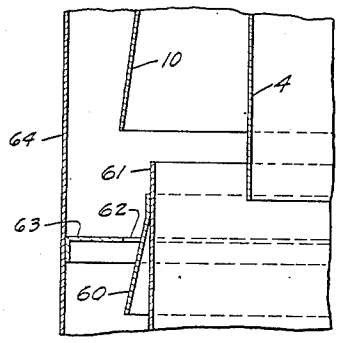

Fig. 8

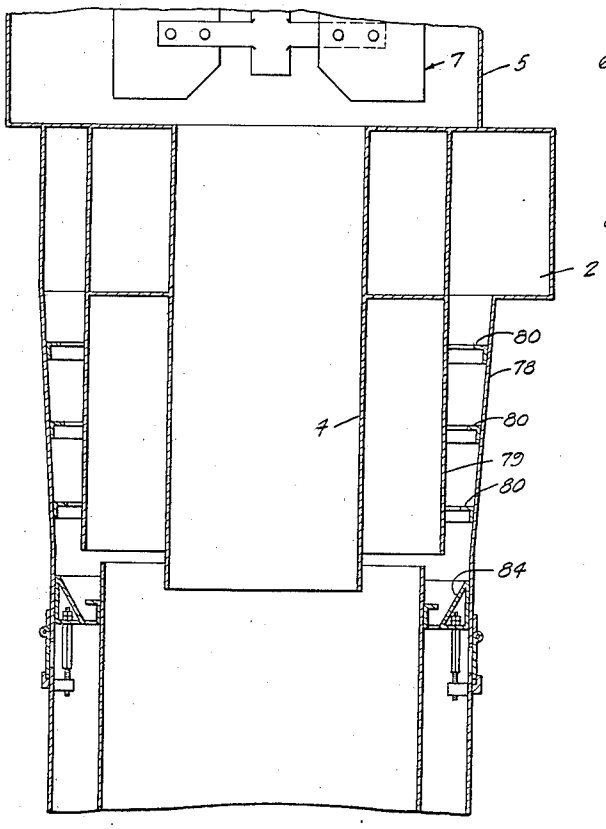

Fig. 11

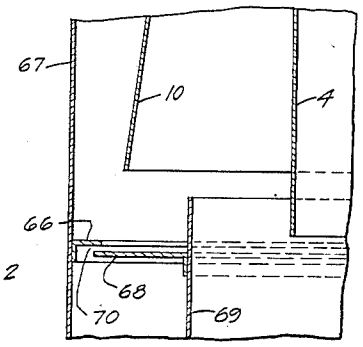

Fig. 9

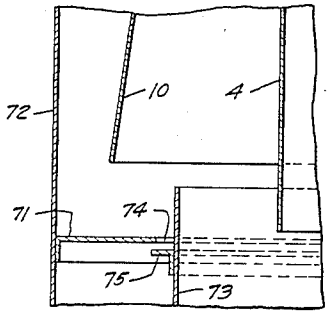

Fig. 10

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CENTRIFUGAL CLASSIFYING APPARATUS

Filed March 22, 1932 5 Sheets-Sheet 4

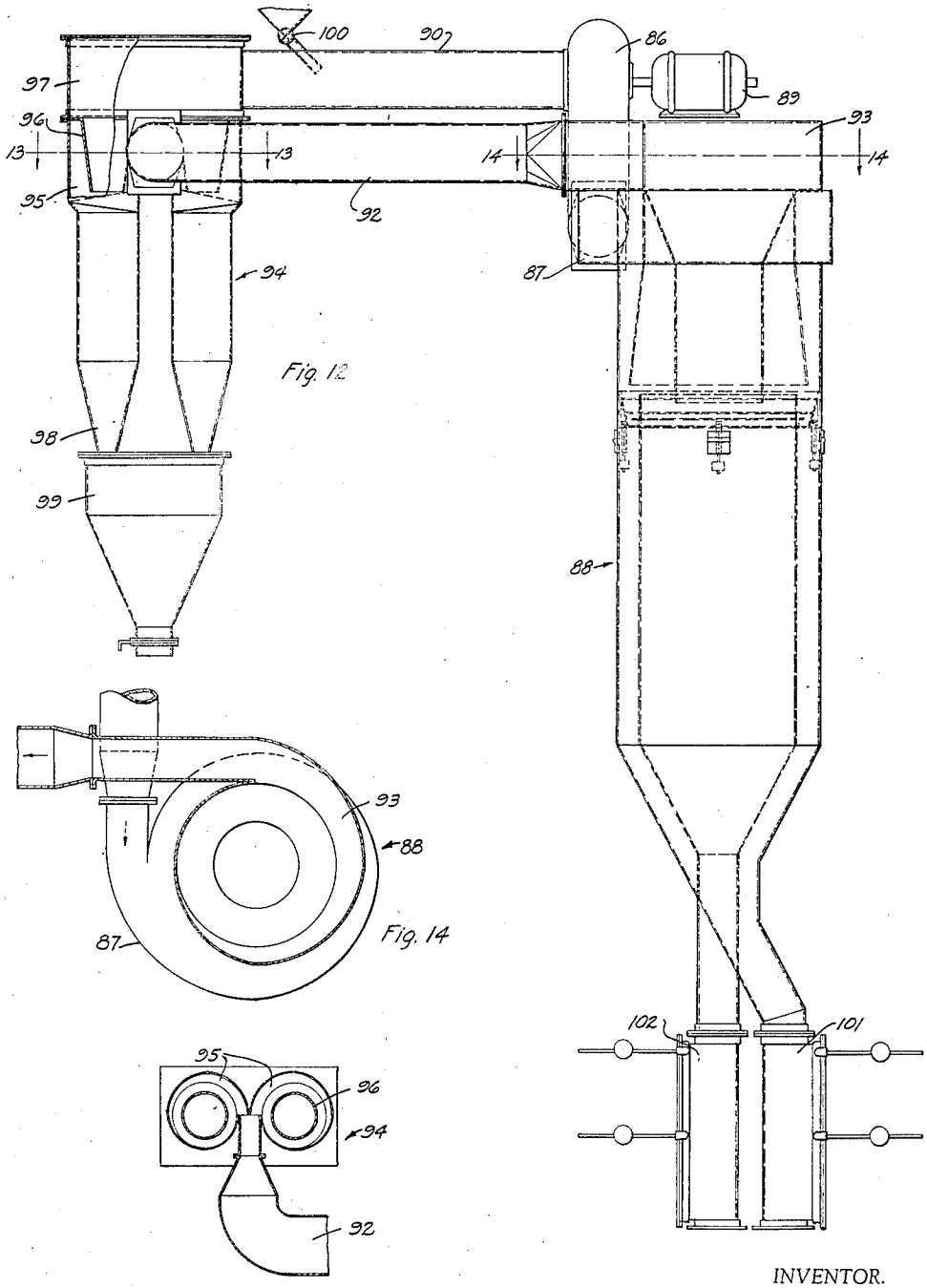

Fig. 12

Fig. 14

Fig. 13

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Oct. 30, 1934. M. A. LISSMAN 1,978,802

CENTRIFUGAL CLASSIFYING APPARATUS

Filed March 22, 1932 5 Sheets-Sheet 5

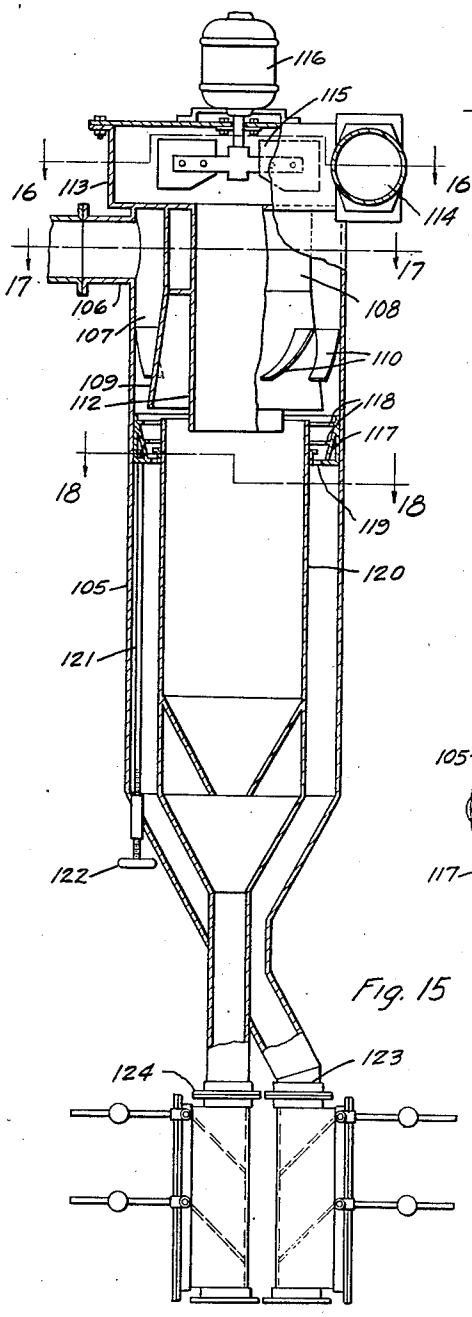

Fig. 15

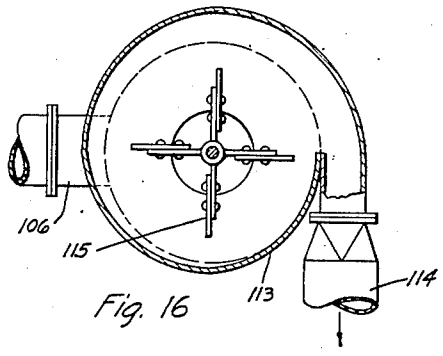

Fig. 16

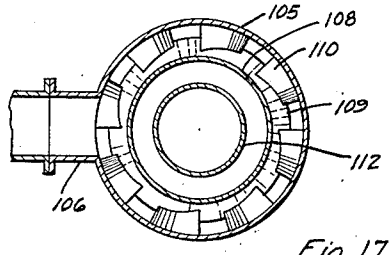

Fig. 17

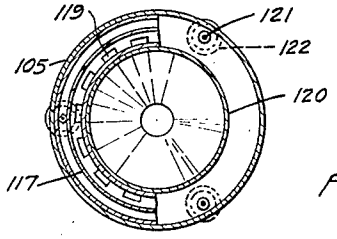

Fig. 18

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UNITED STATES PATENT OFFICE

1,978,802

CENTRIFUGAL CLASSIFYING APPARATUS

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Application March 22, 1932, Serial No. 600,425

12 Claims. (Cl. 209—144)

This invention relates to apparatus for selectively separating suspended material from gases by centrifugal action, and the main object of the invention is to provide apparatus of this character which will separate suspended material from gases and at the same time separately collect portions of such material of different fineness so that the apparatus serves both as a separator and as a classifier for the separated material.

Other objects of the invention will appear hereinafter.

The accompanying drawings illustrate embodiments of my invention, and referring thereto:

Fig. 1 is a vertical section partly in elevation of one form of the invention.

Fig. 2 is an enlarged vertical section of the upper part of the construction shown in Fig. 1.

Fig. 3 is a horizontal section on line 3—3 in Fig. 2.

Fig. 4 is a horizontal section on line 4—4 in Fig. 2.

Fig. 5 is a horizontal section on line 5—5 in Fig. 2.

Fig. 6 is a partial vertical section showing a modification of the parts in the separating zone.

Figs. 7 to 11 inclusive, are partial vertical sections showing further modifications of such parts.

Fig. 12 is a side elevation partly in section of a modification of the invention provided with external means for propelling the gas and with means for feeding suspended material to the gas stream in case the apparatus is used solely as a classifier, and also with auxiliary collecting means for separating the most finely divided portion of material from the gas stream.

Fig. 13 is a section on line 13—13 in Fig. 12.

Fig. 14 is a section on line 14—14 in Fig. 12.

Fig. 15 is a vertical section, partly in elevation, of a modified form of the invention in which the whirling motion of the air or gas is effected by deflecting vanes.

Fig. 16 is a section on line 16—16 in Fig. 15.

Fig. 17 is a section on line 17—17 in Fig. 15.

Fig. 18 is a section on line 18—18 in Fig. 15.

The apparatus shown in Figs. 1 to 5 comprises a circular casing 1 preferably formed as a vertical cylinder connected at its open upper end to an inlet chamber 2 into which leads an inlet pipe 3, said chamber 2 being provided with an involute or spiral wall portion 2' as shown in Fig. 4 to direct the gas tangentially into the upper portion of the cyclone chamber 1. A tubular outlet member 4 extends downwardly within the casing 1 and coaxially therewith, said member being formed, for example, as a vertical cylindrical tube opening at its upper end into an outlet chamber 5 communicating with an outlet 6, said chamber 5 being preferably formed as shown in Fig. 3 with an involute or spiral wall portion 5' leading to said outlet 6. A partition plate 22 separates the inlet and outlet chambers but is provided with a central opening 4' establishing communication between the interior of outlet tube 4 and outlet chamber 5. A centrifugal fan or impeller 7 is mounted within the chamber 5, being carried by the shaft 8 of a suitable motor, such as electric motor 9, which is provided with usual or suitable energizing and controlling connections, not shown, so as to operate the centrifugal fan at suitable speed and in a direction such as to force the gas toward the outlet 6, the spiral or involute wall of said chamber 5 enabling the outlet portion of said chamber to serve as a diffuser.

A tubular deflector 10 extends concentrically within the casing 1 and around the outlet member 4 so as to define between the casing 1 and the member 10 an annular passage 11 whose radial width is small compared to the radius of the casing 1, the said member 10 preferably flaring downwardly so that the radial width of said passage 11 decreases progressively in a downward direction, said passage 11 terminating at its lower end in a comparatively narrow annular throat 11'. The inner tubular return member 4 is shown as connected to the deflector member 10 by transverse webs 13, it being understood that the space between these inner and outer tubular members is substantially a dead space, being closed at its upper end by partition 22, and it is immaterial whether or not these webs be used.

A fines collecting chamber is mounted concentrically within the chamber 1 and consists of a vertical cylinder or separator member 12 of somewhat smaller diameter than the lower end of the member 10, said member 12 being mounted with its open upper end 12' at about the same level as the lower end 10' of the member 10 but preferably slightly below said level. The outlet member 4 extends downwardly to about the level of the upper end of member 12 and preferably somewhat below said level. Collecting chamber 12 is formed with a funnel 14 at its lower portion and with a second funnel 15 below the funnel 14 and opening at its lower end

into a discharge flue 16. The lower end of the cyclone casing 1 is formed with a funnel 18 conducting the coarse collected material to a discharge chute 19. The respective discharge chutes 16 and 19 communicate with discharge gates 20 and 21 respectively, located in suitable housings 20' and 21', whereby the collected material may be removed continuously or from time to time as may be desired. Said discharge gates are shown as weighted, so as to open and discharge the collected material on accumulation thereof in the chutes, but any suitable form of discharge gates, or other material-removing means may be used.

Directly below the throat 11' aforesaid, is arranged a deflecting means 23 preferably formed with one or more horizontal deflecting flanges 24. In the form shown in Figs. 1 and 2, the member 23 is formed as a frusto-conical member which tapers downwardly and the flanges 24 extending inwardly from said member are formed as annular horizontal flanges, the internal diameter of said annular flanges decreasing in descending order. Said member 23 is shown as carried by a cylindrical supporting member 25, which is mounted to slide within the cyclone casing 1 and is provided with means for holding it at any desired vertical position. For this purpose screws 27 may be provided, working in nuts 28 mounted in fixed position on the casing 1 and rotatably engaging with a horizontal flange 29 on member 23, so as to raise or lower said member upon rotation of said screws. Suitable openings 30 may be provided in the casing 1 enabling access to squared portions 31 on screws 27 for adjustment thereof, said openings being normally closed by doors 32. The horizontal flange 29 is preferably extended inwardly across the annular passage 34 between the cylinder 12 and the outer casing 1 and may be connected to the lower end of deflecting member 23. Said flange is provided with openings 35 through which separated material may descend in said passage, a vertical upwardly extending sleeve 36 being preferably provided at the inner edge of the horizontal flange 29 and having at its upper end an outwardly extending horizontal flange 37 which projects over the openings 35 but is spaced from member 23. The vertical sleeve 36 slides closely on the cylinder 12 in the vertical movement of member 23.

A blower or exhaust means 38 may be provided for drawing air or gas from the space 39 within member 12 and below the funnel 14 for the purpose hereinafter described.

In the operation of this form of my invention, the gas to be treated is supplied through the pipe 3 to the inlet chamber 2 and the impeller 7 is set in rapid rotation to induce a draft through the apparatus which causes the gas to be drawn through the inlet chamber 2 and delivered into the upper part of the passage 11 with a high tangential velocity, resulting in a whirling movement of the gas combined with a downward component of motion so that the gas eventually issues at the contracted throat 11' with a vortical movement and then passes under the lower edge 10' of member 10 and over the upper edge 12' of cylinder 12 and under the lower edge of outlet member 4 and upwardly through said outlet member to the fan or impeller chamber 5. In said chamber the air or gas which is still whirling with a considerable tangential velocity is brought in contact with the inner portions of the blades of the impeller which are moving at about the same tangential velocity and by the operation of the impeller and the involute casing 5 thereof, the air or gas is forced outwardly by centrifugal action and delivered at the outlet 6. The gas being treated is assumed to carry suspended material of different degrees of fineness and such suspended material is selectively separated in the above-described operation in the following manner.

As the gas carrying the suspended material passes downwardly within the annular passage 11 with a high tangential component of velocity the suspended material, especially the coarser particles thereof, is thrown outwardly toward the wall of casing 1 so that is descends along said wall in a relatively thin cylindrical sheet. On reaching the contracted throat 11' the gas passes downwardly with increased velocity due to the contraction thereat and then passes inwardly and upwardly between the lower edge 10' of member 10 and the upper edge 12' of member 12, and in this reversal of motion of the gas the heavier particles become separated from the gas stream. It will be noted that in this operation the gas passes inwardly as well as upwardly and the coarser materials are held outwardly by the action of centrifugal force due to the rapid whirling movement so that the heavier particles accumulate and spill over the flanges 24 and are eventually discharged through the openings 35 into the passage 34 and into the material discharge means communicating therewith. The flanges 24 and 37 serve to trap the separated suspended material and prevent it from being picked up and carried forward by the gas stream. The air or gas still possesses sufficient vortical motion when it passes over the upper edge of separator 12 to cause it to pass downwardly to a considerable depth within said separator, while also passing gradually inwardly and then upwardly therein to the outlet tube 4. The arrows in Fig. 1 represent only the components of this gas circulation in the plane of the drawing, without any attempt to indicate the rotational component which also persists throughout such circulation.

In this operation the horizontally extending lip or flange 37 over the openings 35 tends to prevent the heavier particles from being drawn back by entraining action of the gas current. The separation of the coarser particles as the gas passes under the lower edge of the member 10 is effected mainly by the centrifugal action on such particles due to their high vortical velocity tending to hold them outwardly toward the wall of casing 1, while the gas is forced inwardly by the suction from the impeller means and by the action of the deflector means 23; secondly, by the inertia or momentum of the coarser particles which tends to maintain their downward component of motion and thereby separate them from the gas stream which is deflected inwardly and upwardly by the deflector means 23 and 24 and separator means 12; and thirdly, by the action of gravity which tends to cause the coarser heavier particles to spill over the flanges 24 and through the outlets 35 as aforesaid. The throat 11' and the zone of classification indicated at 40 between the members 10, 23 and 12, are of small transverse dimensions as compared to the diameter of the casing, and also as compared with the diameter of the members 10 and 12, so that a sufficiently high velocity of the gas is maintained at the

throat 11' and in said separating and classifying zone to insure that the fines will be carried forward by the gas stream and the coarse particles will be forced out of the gas stream as above described.

The gas passes from the classifying zone under the lower edge 10' and into the cylindrical separator member 12, wherein it is subjected to a separating action by cyclonic or vortical motion, causing the fines to be separated therefrom to a greater or less extent, the relatively clean gas thence passing upwardly through the outlet tube 4. The separating operation in the separator member 12 is effected by the centrifugal action of the rapidly whirling gas within said member, it being understood that the gas enters the upper end of said separator member with a high tangential velocity together with a downward component of motion. This results in a pressure head representing an excess of pressure at the peripheral portion or zone of the vortically moving body of gas and a deficiency of pressure in the central portion or core of such body. As the gas descends in the cylindrical separator member 12, the tangential velocity is gradually decreased by reason of the friction against the wall of the separator member so that when the gas reaches the tapered outlet cone or funnel 14 at the bottom of said member, the radial pressure head thereon is sufficiently decreased to enable the longitudinal pressure head originally imposed upon the gas to force the gas inwardly as it descends in the outlet cone 14. The proportions of the parts are preferably such that the pressure at the periphery of the outlet opening 14' at the bottom of cone or funnel 14 is somewhat greater than the pressure in the lower outlet cone or funnel 15, so that there is a positive ejecting action on the suspended particles at the peripheral portion of the outlet opening, it being understood that due to the vortical motion the suspended particles, being heavier than the gas, are thrown outwardly into the peripheral zone adjacent the wall of the separating unit and descend along or adjacent such wall until they reach the outlet opening 14'. Concurrently with the above-described operation, there is an inward flow of relatively clean gas toward the center of the separating member and upwardly to the outlet tube 4, and the stream of relatively clean gas passes upwardly through the said outlet tube.

It will be observed that both the relatively coarse particles separated from the gas in the classifying zone and the relatively fine particles separated in the separator 12 are removed from the gas before it reaches the impeller, so that only a very small proportion of the solid particles delivered to the apparatus are permitted to contact the impeller blades, and any such particles are necessarily extremely fine or light. For this reason, the wear on the impeller blades is substantially eliminated or reduced to a minimum, and this feature is of particular importance in view of the high speed at which the impeller is operated, for if any appreciable quantity of solids, and particularly the coarser solids, were permitted to contact the impeller blades moving at this high velocity, such blades would be worn away very rapidly.

By keeping the annular space 11 between the external cylindrical casing 1 and the deflector means 10 of small radial depth, the rate of shear in the gas stream at the outside wall is kept very high. As a result, there is a zone immediately adjacent the wall of deflector means 10, in which energy is dissipated at a high rate, thus creating a zone of strong eddies. These eddies agitate the material which tends to collect against the wall of casing 1, so that the fines adhering to the coarser particles are forcibly freed by attrition and carried toward the main gas stream by the eddies. The classifying zone is so proportioned and the component of velocity radially inwards is kept sufficiently high to carry along the particles which are of smaller diameter than those desired in the coarse cut. By keeping the tangential component of velocity in the classifying zone high, the particles are subjected to a high radial acceleration, many times that of gravity. This permits the inward component of velocity at the zone of classification 40 to be increased many times over that possible with low velocity classifiers. This results in a unit which is very compact for the tonnage which can be handled, as the weight of material which can be kept in suspension in a gas stream increases rapidly with increasing velocity, and while the energy required to handle a unit volume of gas at the higher velocity is increased, the weight of material classified per unit volume also increases.

The dispersion of the material to be classified is still further improved by the horizontal flanges 24, which force the material away from the external wall towards the more active zones of gas circulation, enhancing the chance of the fines being picked up and carried along by the main gas stream.

While the design is such as to create strong eddies in the dispersion zone adjacent the outer walls, sufficient tangential component of velocity remains to obtain smooth stream lines of flow in the classification zone, without major eddies. The inertia of the larger particles makes them move downwardly away from edge 10' of the deflector 10, due to the downward component of velocity in the annular space between 1 and 10. The separation or classification zone 40 is so proportioned that the larger particles which it is desired to separate can not reach the edge 10', but are thrown again into the descending stream due to the high radial acceleration maintained in the classification zone. These proportions can be altered to suit different materials and to classify at different degrees of fineness by moving the flange means 23 up and down and also, if desired, by adjusting the upper edge of tubular member 12, as hereinafter set forth.

In practice the passage between edges 10' and 12' is made of sufficient radial depth to ensure that an oversized particle will be forcibly ejected out of the inner vortex moving towards the gas outlet of the classifying zone, before edge 12' is reached, and all such oversize particles eventually spill over the flange means 24 and pass through openings 35 and to the coarse material outlet means 19.

By reason of the fact that the circumference of the classifying zone 40 adjacent the lower end of the tubular deflector member 10 is approximately the maximum circumference of the apparatus, a comparatively large total cross-section of such zone with accompanyingly large operating capacity is secured, while at the same time the narrow transverse dimension of such zone between said lower edge and the deflector means 23 and 12 provides the high velocity and sharp curvature of motion which produces the close classifying effect desired.

If desired, provision may be made for adjustment of any of the deflecting means above described in addition to or alternatively with adjustment of the flange means which extend inwardly from the outer casing. Thus, as shown in Fig. 6, the tubular outlet member 44, which is mounted coaxially within the outer casing 41 and within the tubular deflector flange 42, may be provided with a downward extension 45 adjustably mounted thereon by bolt and slot connections 46, so as to adjust the lower edge 45' of the member 45 upwardly or downwardly to give optimum separating conditions. Similarly, the inner lower partition cylinder 47, which is mounted within the outer casing 41 below the tubular deflector means 42, may be provided with an adjustable extension 48 mounted thereon by bolt and slot connections 49 providing for vertical adjustment of the member 48 to bring its upper edge 48' to the most effective position. The flange means 50 extending inwardly from the outer casing 41, is also shown as mounted by bolt and slot connections 51 to provide for vertical adjustment of same. In this form of the invention said flange means is shown as provided with a plurality of horizontal flanges 52 and with passage means 53 between the lowermost flange means 52' and the inner cylinder 47 for passage of coarse material into the space 54 between the members 41 and 47. In other respects the construction and operation of this form of the invention may be the same as above described.

As shown in Fig. 7, the deflector flange means may consist simply of a horizontal flange 55 extending inwardly from the outer casing 56 to the inner lower partition cylinder 57, opening means 55' being provided near the inner edge of said flange to permit passage of coarse material therethrough. Said flange means may be provided with an upwardly extending sleeve 58 fitting closely around cylinder 57 and having an outwardly extending flange 58' located over the openings 55' and serving to deflect the gas upwardly and the coarse material downwardly toward the openings 55'. The construction of this form of apparatus may be otherwise similar to that above described and the operation is also similar, it being understood that in practice more or less coarse material will generally accumulate on the flange 55 in a layer whose slope corresponds to the angle of repose of the coarse material under the conditions present. The upper deflector tube and outlet tube are shown at 10 and 4 respectively.

As shown in Fig. 8, an apron 60 may extend downwardly and outwardly from the lower partition cylinder 61 adjacent a coarse material outlet passage means 62 between said cylinder and the horizontal deflector flange 63 which extends inwardly from the outer casing 64, this apron permitting descent of coarse material but tending to obstruct the return of coarse material through said passage means.

The deflector flange means extending inwardly from the outer casing in the forms of the invention above described, operates as a trap for selectively removing the coarse particles from a gas stream and allowing such particles to fall into the coarse material discharge means. Any suitable flange means may be used for this purpose, for example, as shown in Fig. 9, such means may comprise an outer flange 66 extending inwardly from the outer casing 67 and an inner flange 68 extending outwardly from the inner partition member 69 somewhat below the flange 66 and spaced therefrom to form a discharge opening 70 for coarse material. In Fig. 9 the discharge outlet 70 is near the wall of the outer casing, the flange 66 being relatively narrow and the flange 68 being relatively wide, but if desired the discharge outlet for coarse material may be located near the inner member as shown in Fig. 10, the upper flange 71 extending from the outer casing 72 nearly to the inner partition cylinder 73 leaving a discharge opening 74 between said parts, and the lower flange 75 is relatively narrow and extends from the inner member 73 directly under the discharge outlet 74.

It is preferred to so construct the apparatus that the annular passage between the outer casing and the tubular deflector decreases in radial dimension toward the bottom, so as to produce maximum speed at the throat where the gases leave such annular passage and enter the classifying zone. In the form shown in Fig. 1, this effect is secured by increasing the diameter of the tubular member 10 toward its lower end, but as shown in Fig. 11, the same effect may be secured by decreasing the diameter of the outer casing 78 from the inlet chamber 2 to the bottom of the tubular deflector means 79. As illustrated in this figure, horizontal flanges or baffles 80 may also be provided within said annular passage, said horizontal flanges extending inwardly from the wall of casing 78 and forming obstructions which force the gas and the material carried thereby momentarily away from the wall of said casing, thereby producing eddies which aid in knocking off the finer particles which tend to adhere to the coarse particles. Also, as illustrated in this figure, the flange member indicated at 84 may be formed as a plain cone without horizontal flanges, the construction and mounting of such flange member being otherwise as above described.

In the drawings, the casing of the apparatus is shown as mounted with its cylindrical axis vertical, this being generally the most convenient arrangement and permitting the action of gravity to reenforce to some extent the classifying and separating actions. However, my invention is not limited to such an arrangement, as the casing and the tubular members associated therewith may extend horizontally or at any desired inclination, modifications being made where necessary in the discharging means for the divided material, it being understood that the gravitative action is small compared to the centrifugal forces exerted as above described, and the classifying and separating operations will be effective irrespective of the angular position of the apparatus. It will be further understood that the components of motion which tend to move the suspended material, either coarse or fine as the case may be, toward the discharge or outlet means therefor, are not necessarily vertical, but, in any case, such components are longitudinal or parallel to the axis of the apparatus, as distinguished from the tangential components which tend to separate, first, the coarse particles, and later, the fines, from the gas stream.

The blower or gas propelling means may be located either within the classifier apparatus as above described or outside of same, and either in advance of the classifier or behind the classi-

fier. Thus, as shown in Fig, 12, the blower indicated at 86 may be connected to the inlet chamber 87 of the classifier 88 so as to force the air or gas tangentially into said chamber with sufficient velocity and pressure to effect the separating operation as above described. Said fan or blower 86 is operated by a suitable motor 89 and has its inlet 90 connected to suitable means for supplying the gas to be treated. In case it is desired to also collect the extremely fine material which passes through the classifier without collection, the outlet pipe 92 leading from the outlet chamber 93 of the classifier 88 may be connected to suitable collecting means of any suitable type, for example, as shown in Fig. 12, to a cyclonic separator 94 having its tangential inlets 95 connected to the pipe 92 and having its central outlets 96 connected to an outlet header 97. Said collecting apparatus 94 is shown as comprising a plurality of separator tubes having tangential inlets connected to the pipe 92 as above described and being provided at their lower ends with constricted outlets 98 for discharging collected material to suitable receiving means 99.

While the apparatus is especially designed and adapted for separation of material from a gas stream containing suspended material of different grades of fineness, it may also be used to advantage as an ordinary classifier, the finely divided solid material being in that case fed by suitable means indicated at 100 to the inlet pipe 90 for the blower 86, and being carried forward and distributed in the gas stream by the entraining action of the air or gas current and by the agitation of the fan or blower 86. In this application of the invention the apparatus may operate on closed circuit, the inlet pipe 90 for the blower 86 being, for example, connected directly to the outlet header 97 for the separator or collector 94. The construction of the classifier 88 in this form of the invention may be similar to that above described in connection with Fig. 1, and said classifier operates to separate and collect the coarse material in the delivery means 101, and the intermediate material in the delivery means 102, the extreme fines being separated in the separator 94 and collected in the delivery means 99 aforesaid.

In the form of the invention shown in Figs. 15 to 18, the whirling movement of the air or gas is produced by deflecting vanes. The inlet 106 for the gas enters non-tangentially into the inlet chamber 107 at the upper part of the cylindrical classifier casing 105, and the deflecting vanes 110 are formed as helical segments mounted on a downwardly flaring extension 109 of an inner deflector member 108, so as to impart a tangential component of motion to the gas or air passing downwardly from the inlet chamber 107 to the contracted throat or passage between the lower end of the member 109 and casing 105. An outlet pipe 112 extends coaxially with casing 105 and inside the members 108 and 109, and opens at its lower end into the interior of said casing and at its upper end into an outlet chamber 113 provided with a tangential outlet 114. An impeller or fan 115 is mounted within the chamber 113 and driven by motor 116 so as to induce a draft through the apparatus in the manner above described.

Deflector means 117 provided, if desired, with flanges 118 is mounted below the lower end of the deflector means 109 and is provided with openings 119 permitting passage of separated material into the space between the casing 105 and an inner cylindrical separator member 120, this space discharging coarse material into delivery means 123 and the space within the separator member 120 delivering discharging fines to the delivery means 124.

The means for adjusting the deflector means 117 is shown in this case as comprising adjusting screws 121 rotatably connected to the member 117 and extending through the funnel-shaped bottom of the casing 105 and provided at the lower ends thereof with operating handles 122.

The operation of this form of my invention is similar to that above described, except that the tangential or whirling movement is imparted to the air or gas by the spiral or helical vanes instead of by a tangentially entering stream of gas.

I claim:

1. A classifying apparatus comprising a cylindrical casing provided at one end with an inner tubular deflector member and at the other end with a cylindrical separator member mounted coaxially within said casing, a central outlet tube extending coaxially within said casing and within said tubular deflector means, means for supplying gases carrying suspended material to the space between said casing and said tubular deflector member and for imparting whirling movement to said gases, deflecting flange means extending inwardly from the cylindrical casing adjacent the end of the passage between said casing and said tubular deflector member, said tubular deflector member, cylindrical separator member and outlet tube having edge portions adjacent to one another and to said deflecting flange means to cause the gas discharged from the passage between the casing and the tubular deflector member to be deflected first between the edges of the tubular deflector member and the separator member, then longitudinally within said separator member, and then reversely in a longitudinal direction through said outlet tube, and outlet means connected to said outlet tube.

2. An apparatus as set forth in claim 1, in which said outlet means comprises an outlet chamber, a rotary fan mounted in said chamber, and means for operating said fan to induce flow of gas from said inlet through the said apparatus and the outlet tube thereof.

3. A classifying apparatus comprising a cylindrical casing, a tubular deflector member extending downwardly from the upper end of said casing and coaxially therein and of less diameter than said casing, means for supplying gas containing suspended material downwardly with a whirling motion within the space between said casing and said tubular deflector member, a cylindrical separating member open at its upper end and mounted coaxially within the lower portion of said cylindrical casing and of less diameter than said tubular deflector member, said separating member having its upper edge at a level adjacent the lower edge of said tubular deflector member but spaced therefrom so as to provide for inward passage of gas between the lower edge of said deflector member and the upper edge of said separating member, the space between said casing and said separating member communicating at its upper end with the space between said casing and said deflector member so as to receive material separated from the gas outwardly of said separating member, and the

space within said separating member serving to receive material separated from the gas inwardly of said separating member, material discharge means connected to the space between said casing and said separating member, separate material discharge means connected to the space within said separating member, and a tubular outlet member of less diameter than said separating member disposed concentrically within the upper portion of said casing and communicating at its lower end with the space within said separating member.

4. An apparatus as set forth in claim 3, and also comprising deflecting flange means projecting inwardly from said casing below said tubular deflector member and around said separating member and providing an opening positioned inwardly from said casing for passage of separated material into the space between the casing and the separating member and below said flange means.

5. A classifying apparatus as set forth in claim 3, and comprising, in addition, annular deflecting flange means projecting inwardly from said casing below said tubular deflector member and around said separating member and providing an opening positioned inwardly from said casing for passage of separated material into the space between the casing and the separating member and below said flange means, and means for vertical adjustment of said annular deflecting flange means to vary its position relative to the lower edge of the tubular deflector member.

6. A classifying apparatus comprising a circular casing, a tubular deflector member extending downwardly within said casing and concentrically thereof, means for delivering gas downwardly with a whirling motion in the annular space between said casing and deflector member, a tubular separating member disposed concentrically within said casing below said deflector member and of less diameter than said deflector member, an outlet tube disposed concentrically within said deflector member and of less diameter than said separating member, gas outlet means connected to said outlet tube, and separate material collecting means connected to the interior of said separating member and to the annular space between said separating member and said casing.

7. An apparatus as set forth in claim 6 and comprising, in addition, deflecting flange means projecting inwardly from said casing below said deflector member and around said separating member, opening means being provided for passage of material downwardly between said flange means and said separating member and into said annular space between the separating member and the casing.

8. An apparatus as set forth in claim 6, the lower edges of said tubular deflector member and said outlet tube being disposed at a level adjacent that of the upper edge of said tubular separating member.

9. An apparatus as set forth in claim 6, and comprising, in addition, deflecting flange means projecting inwardly from said casing below said deflector member and around said separating member and providing opening means for passage of material downwardly into said annular space between the separating member and the casing, and means for vertical adjustment of said deflecting flange means to vary its position relative to the lower edge of said tubular deflector member.

10. In a classifying apparatus, a vertically elongated substantially cylindrical casing, a vertically elongated substantially cylindrical separating member disposed substantially concentrically within the lower portion of said casing, said separating member being open at its upper end and of somewhat less diameter than said casing, means for delivering gas containing suspended material downwardly with a whirling motion adjacent the wall of said casing at a position above the upper edge of said separating member, deflecting flange means projecting inwardly from said casing around said separating member at a position adjacent the upper edge of said separating member and having its inner edge spaced from said separating member so as to provide an opening for passage of separated material downwardly between said flange means and said separating member, a gas outlet tube disposed concentrically within the upper portion of said casing and of less diameter than said separating member and communicating at its lower end with the space within said separating member, material discharge means connected to the space between said separating member and said casing below said deflecting flange means, and separate material discharge means connected to the space within said separating member.

11. In a classifying apparatus, the combination as set forth in claim 10, said deflecting flange means comprising a plurality of inwardly projecting flange members disposed at progressively lower levels and of progressively decreasing internal diameter.

12. In a classifying apparatus, the combination as set forth in claim 10 and also comprising means for vertical adjustment of said deflecting flange means to vary the position thereof with relation to the upper edge of said separating member.

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